

# The Epidemiology of Raw Milk–Associated Foodborne Disease Outbreaks Reported in the United States, 1973 Through 1992

## ABSTRACT

**Objectives.** This study describes the epidemiology of raw milk–associated outbreaks reported to the Centers for Disease Control and Prevention from 1973 through 1992.

**Methods.** Surveillance data for each reported raw milk–associated outbreak were reviewed. A national survey was conducted to determine the legal status of intrastate raw milk sales for the period 1973 through 1995.

**Results.** Forty-six raw milk–associated outbreaks were reported during the study period; 40 outbreaks (87%) occurred in states where the intrastate sale of raw milk was legal.

**Conclusions.** Consumption of raw milk remains a preventable cause of foodborne disease outbreaks. (*Am J Public Health.* 1998;88:1219–1221)

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## Introduction

The hazards of drinking raw milk are evident from the list of infectious diseases that may be acquired from this product; these include campylobacteriosis,<sup>1</sup> salmonellosis,<sup>2</sup> yersiniosis,<sup>3</sup> listeriosis,<sup>4</sup> tuberculosis,<sup>5</sup> brucellosis,<sup>6</sup> staphylococcal enterotoxin poisoning,<sup>7</sup> streptococcal infections,<sup>8,9</sup> and *Escherichia coli* O157:H7 infection.<sup>10</sup> Additionally, raw milk has been implicated as a vehicle in the transmission of Brainerd diarrhea.<sup>11</sup>

The purpose of this study was 3-fold. First, we produced a description of the epidemiology of raw milk–associated outbreaks reported to the Centers for Disease Control and Prevention; CDC) from 1973 through 1992. Second, we determined whether rates of reported raw milk–associated outbreaks differed between states in which the sale of raw milk was legal at the time of the outbreak and states where the sale of raw milk was illegal. Finally, we investigated whether the mean annual number of outbreaks reported for the period prior to 1987 differed from that beginning in 1987, when the US Food and Drug Administration implemented a ban on the interstate sale of raw milk.

## Methods

We reviewed all outbreaks of foodborne disease reported to the CDC from 1973 through 1992 for which the implicated vehicle was raw milk. A foodborne disease outbreak was defined as an incident in which 2 or more persons experienced a similar illness after ingestion of a common food. Raw milk was defined as unpasteurized milk or milk not pasteurized according to recognized standards required by the Code of Federal Regulations (21 CFR 1240.61). A descriptive analysis of foodborne disease report data was conducted with SAS.<sup>12</sup>

In early 1995, we mailed a survey to regulatory officials in all 50 states, Puerto Rico, and the District of Columbia to determine the legality of raw milk sales within each state during the period 1973 to 1995. States that reported that raw milk sales became either

legal or illegal during this period were asked to specify the date of the change. State milk officials were also asked to estimate the quantity of both pasteurized milk and, if legal, raw milk sold in their state for the most recent year such information was available.

To assess the impact of state regulations concerning intrastate raw milk sales on reported raw milk–associated outbreaks, outbreak data were combined with state survey results. To calculate the rate of reported raw milk–associated outbreaks during the study period (1973–1992) for states where the intrastate sale of raw milk was legal, we used the number of outbreaks reported from such states as the numerator and the number of state-years during which the intrastate sale of raw milk was legal as the denominator. Similarly, to calculate the rate of reported raw milk–associated outbreaks for states where the intrastate sale of raw milk was not legal at the time of the outbreak, we used the number of outbreaks reported from such states as the numerator and the number of state-years during which the intrastate sale of raw milk was not legal as the denominator. The results of the survey were used to determine the legal status of intrastate raw milk sales for each state at the time of occurrence of each reported outbreak. We also compared the number of reported outbreaks per 10 million person-years between those states in which the intrastate sale of raw milk was legal at the time of the outbreak and those states in which such sale was not legal.

## Results

Forty-six raw milk–associated outbreaks were reported to the CDC from 21 states dur-

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ing the study period (Table 1). The median number of persons who became ill in the outbreaks was 19 (range, 2 to 190). Thirty-eight reported outbreaks occurred prior to 1987 (mean, 2.7 outbreaks per year), compared with 8 outbreaks after 1987 (mean, 1.3 outbreaks per year). In 38 reported outbreaks (86%), the implicated raw milk was produced at a commercial dairy.

Survey responses regarding the legal status of raw milk sales were received from all 52 jurisdictions (the 50 states plus Puerto Rico and the District of Columbia). At the time of the survey, 28 states (54%) permitted the intrastate sale of raw milk (Figure 1). In all states where the sale of raw milk was legal, the estimated volume of raw milk sold as a percentage of the total milk sold (i.e., pasteurized and unpasteurized milk) was less than 1%.

Forty (87%) of the 46 reported raw milk-associated outbreaks occurred in states in which the intrastate sale of raw milk was legal at the time of the outbreak. Specifically, 6 outbreaks were reported during 476 state-years for states in which the intrastate sale of raw milk was not legal (1.26 outbreaks per 100 state-years), compared with 40 outbreaks during 544 state-years for states in which the intrastate sale of raw milk was legal (7.35 outbreaks per 100 state-years). The number of reported outbreaks per 10 million person-years in states that permitted the intrastate sale of raw milk was 0.14, compared with 0.03 outbreaks per 10 million person-years in states where the intrastate sale of raw milk was illegal. Of the 8 reported outbreaks that occurred after implementation of the 1987 ban on the interstate sale of raw milk, 7 occurred in states where the sale of raw milk was legal.

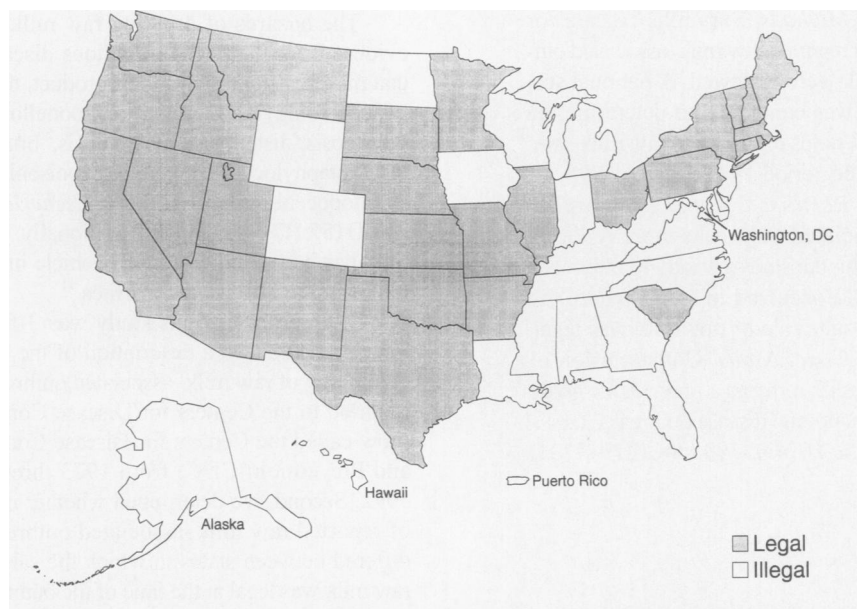
## Discussion

Consumption of raw milk is far less prevalent than consumption of pasteurized milk in the United States; we found that raw milk accounted for less than 1% of total milk sold in states that permit the sale of raw milk. Nevertheless, despite implementation in 1987 of the ban on the interstate sale of raw milk, raw milk consumption has continued to cause outbreaks of illness. With one exception, all outbreaks reported after 1987 occurred in states that permitted the intrastate sale of this product. We found that the rate of raw milk-associated outbreaks reported during the study period was far higher for states in which the sale of this product was legal than for states in which it was not legal. This suggests that banning the intrastate sale of raw milk could reduce the number of raw milk-associated outbreaks.

We also found that the mean annual number of reported outbreaks during the study

**TABLE 1—Etiology of Raw Milk–Associated Foodborne Disease Outbreaks Reported to the Centers for Disease Control, 1973–1992**

Pathogen	No. of Outbreaks (%)	No. of Cases
<i>Campylobacter</i>	26 (57)	1100
<i>Salmonella</i>	12 (26)	331
Staphylococci	1 (2)	15
<i>Escherichia coli</i> O157:H7	1 (2)	6
Unknown	6 (13)	281
Total	46 (100)	1733



**FIGURE 1—States reporting legal intrastate sale of raw milk as of May 1995.**

period after 1987 was much lower than that for the period prior to 1987 (1.3 vs 2.7). However, because the outbreak surveillance data collected by the CDC did not specify the state where the implicated raw milk was produced, we were unable to determine whether each outbreak resulted from interstate or intrastate sales of raw milk. Consequently, we could not draw any firm conclusions about what role the ban on interstate sale of raw milk implemented in 1987 may have had in contributing to the observed reduction in the mean annual number of outbreaks reported from 1987 through 1992.

An additional limitation of this study is that it most likely captured only a fraction of the number of outbreaks that actually occurred in the study period. A review by Wood and others of *Campylobacter* enteritis outbreaks in the United States associated with drinking raw milk during youth activities indicated that only 60% of outbreaks identified by states between 1981 and 1988 were reported to the CDC.<sup>13</sup> Furthermore, sporadic cases of milk-borne illness are not reported as part of this surveillance system. Historically, many more

cases of sporadic foodborne disease have been reported than cases associated with outbreaks.<sup>14</sup> Despite these limitations, the results of this study illustrate the dramatically higher rate at which raw milk-associated outbreaks are reported from states that allow the sale of this product compared with states where the sale of raw milk is illegal, highlighting the continuing role of raw milk as a vehicle for infectious disease agents. □

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## ABSTRACT

**Objectives.** The purpose of this study was to identify individual characteristics associated with types and frequency of milk consumption in older American adults.

**Methods.** A national probability-based sample (response rate = 91%) completed a telephone survey. Generalized logit and cumulative logit analyses were used to identify predictors of and barriers to fluid milk consumption in 494 elderly people.

**Results.** The likelihood of drinking skim or 1% milk rather than whole milk increased with nutrition knowledge, income, trying to reduce cholesterol intake, and being female ( $P < .05$ ). Frequency of milk consumption was higher with nutrition knowledge, frequency of milk consumption during adolescence, and following a diabetic diet but was lower with milk intolerance.

**Conclusions.** The present results could be used to develop intervention strategies for improving milk consumption rates among older adults. These strategies might focus on increasing elderly people's awareness of milk intolerance and lactose-reduced milk products and their concern about cholesterol. The relationship between current and adolescent milk consumption suggests that intervention strategies should begin early in life. (*Am J Public Health*. 1998; 88:1221–1224)

# Milk Consumption in Older Americans

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## Introduction

Failure to consistently consume the recommended 2 or more servings of milk products per day<sup>1</sup> is a major indicator of low calcium intake and poor nutritional status in older people<sup>2</sup> and is associated with increased risk of osteoporosis.<sup>3,4</sup> Conversely, an adequate intake of calcium has been implicated as a potential factor in the risk reduction of calcium-sensitive hypertension<sup>5</sup> and colon cancer.<sup>6</sup>

The current recommended intake for maximum calcium retention in individuals 51 years of age or older is 1200 mg per day.<sup>7</sup> However, phase 1 data from the Third National Health and Nutrition Examination Survey (NHANES III)<sup>8</sup> indicate that mean daily dietary intakes of calcium are only 721 to 875 mg in men and 626 to 711 mg in women.

One objective of *Healthy People 2000* is to increase calcium intake; the goal is for at least 50% of people 25 years of age and older to consume 2 or more servings of foods rich in calcium per day.<sup>9</sup> A second objective is to reduce the current national average of 36% total calories from fat to the recommended 30%.<sup>9</sup> Skim or 1% milk provides essential calcium but less fat than whole milk.

Although socioeconomic status,<sup>10</sup> physiological factors,<sup>11</sup> nutrition knowledge,<sup>12</sup> health-seeking behaviors,<sup>13</sup> nutritional attitudes,<sup>14</sup> and food patterns established during youth<sup>15</sup> influence eating patterns, limited information exists relating these factors to milk consumption in older adults. Thus, our goal was to determine the predictors of and barriers to the type and frequency of fluid milk consumption among older adults.

## Methods

### Survey Instrument

All procedures were approved by the Institutional Review Board on Human Subjects of the University of Georgia. Data on age, gender, ethnicity, income, and education were obtained with closed-ended questions. Dietary health behaviors were assessed according to Bausell,<sup>13</sup> and milk consumption was measured according to NHANES III.<sup>16</sup> Lactose maldigestion was inferred from a self-report of perceived milk intolerance (defined as experiencing a stomachache, gas, or diarrhea after consuming milk). A 12-item nutrition knowledge instrument was adapted from a 17-item instrument.<sup>17</sup> Attitudes toward convenience, packaging, the shelf life of milk, and milk and sleep were investigated via original questions. The final survey instrument was constructed after input from the University of Georgia Survey Research Center and the National Dairy Council and pilot testing in a pencil-and-paper format in a local sample of 50 adults.

### National Telephone Survey

A telephone survey was conducted in 1994 by the University of Georgia Survey Research Center. Respondents were randomly selected from an enumerated listing of 74 mil-

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